National Aeronautics and Space Administration

Directive: Mapping the Moon with WALL•E

Recommended for Grades 5-8

(appropriate for Grade 4 if students understand graphing)

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Digital Learning Network (DLN)

A DLN interactive videoconferencing event is a one time connection that allows students to experience NASA first-hand. Each event features an integrated educational package of grade-appropriate instruction and activities centered around a 50 minute videoconference. Students participate in a Question and Answer session with a NASA Education Specialist or a NASA Subject Matter Expert.

Overview

Many students have the misconception that NASA only sends astronauts to space, when in reality, NASA has 58 science missions concurrently taking place this year in addition to the Space Shuttle and the International Space Station (ISS). This module will introduce students to a few of upcoming NASA missions, with a focus on NASA's efforts to Return to the Moon with the Lunar Reconnaissance Orbiter (LRO) and the Lunar Crater and Observation Sensing Satellite (LCROSS). This module will also introduce students to the concepts behind satellite data collection with a hands-on demonstration of a laser altimetry (LIDAR) instrument on LRO. Be forewarned, for this module may actually make your students laugh when WALL•E tries to help tell NASA's story.

Grade Levels: 5-8[a]

Focus Question: *What keeps NASA busy when not sending astronauts into space? How does a satellite help us construct topographic maps?*

Instructional Objectives:

- **Engage:** The student will describe the difference between NASA's manned and robotic missions.
- **Explore:** The student will be understand that NASA has a large science program that accomplishes its missions through satellites.
- **Explain:** The student will apply data analysis skills and identify the topography of a given surface by determining the time/distance relationship between that surface and a satellite.
- **Elaborate:** The student will graph the results of the data acquired during an activity.
- **Evaluate:** The student will explain the importance of finding solid water (ice) at the poles of the Moon.

a While the mathematic standards for graphing and data analysis are met, teenagers in grades 7 and 8 may believe they are too old to be entertained by the character WALL-E.

National Standards

National Science Content Standards:

Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Earth and Space Science
- Earth in the Solar System

Science and Technology
- Abilities of technological design
- Understandings about science and technology

History and Nature of Science
- Science as a human endeavor

National Mathematics Content Standards:

- Collect data using observations, surveys, and experiments
- Represent data using tables and graphs such as line plots, bar graphs, and line graphs

National Technology Content Standards:

- Characteristics and scope of technology – development of technology

Sequence of Events

Pre-Videoconference Activity:

What is lunar topography? Lead a discussion with your students so they may understand lunar topographic features. Have students look at photos of the Moon from lpod.wikispaces.com and see the differences in the surface features of the Moon. Define and identify craters, maria and mountains of the lunar surface. Questions to explore with students are: Which side of the Moon has more craters? Why are lunar maria darker than other surface features? Where did the Apollo missions land on the Moon?

Pre-Videoconference Procedures:

1. Identify an open location in your classroom in which the eight (8) student volunteers can line up against a wall. Make sure they have a comfortable amount of space between each other and are not standing shoulder-to-shoulder. These students will represent the topography of the lunar surface. (During the videoconference event, the host will instruct these students to move forward one or two steps to represent different elevations on the lunar surface.)
2. Mark off a starting position that is parallel to the lunar surface, and is about 2 meters away from the wall. Another student volunteer representing the LRO satellite will move horizontally at this distance to eventually be standing in front of each of the eight (8) lunar surface volunteers as the activity progresses.
3. Duplicate the blank graph (p.16) for each participating student and one data sheet (p.17) for the student volunteer designated as the data recorder.
4. Duplicate the Data Table on a large piece of chart paper or a chalkboard for the Recorder to write down the data as it is received in the mission. (Optional)
5. To complete the mission assignment, please designate eleven student volunteers before connecting with the host on the day of the event.
   (8 Lunar Surface representatives, 1 LRO satellite, 1 Timer, 1 Recorder)
6. Gather necessary activity materials (listed below).

During the Videoconference:

1. Assist student volunteers as they take their positions for the activity.
2. Have the Student Data Recorder write the data that is collected on the Data Table or on a large piece of chart paper, a chalkboard or overhead/Smartboard in order to have this information visible for all students throughout the activity.

During the Videoconference: LIDAR Activity Summary

Students will be participating in a hands-on, interactive mission to demonstrate the LIDAR technology that is employed on the Lunar Reconnaissance Orbiter (LRO). This technology will allow NASA scientists to develop a map of the lunar surface. Using student volunteers in the classroom, a kickball, a timer, and graph worksheets, the LIDAR technology will come to life for the students and a topographical map will be created based on the horizontal placement of the student volunteers and the data collected in the mission.

Eight student volunteers will be asked to represent the lunar surface. These students will line up along a wall in your classroom and will be asked to step forward one or two steps by the host. By staggering the students at different distances from the wall, the host will be able to create a specific "topography" that will be mapped through the mission activities. These eight student volunteers will represent the eight data collection points (points 1 through 8) along the lunar surface as the satellite continues to make a swath along the surface of the Moon.

Three other student volunteers will also be needed to fill the roles of the LRO satellite, a timer, and a data recorder. The LRO satellite will proceed along the pre-designated path (approximately 2 meters from the wall or lunar surface), or satellite swath, to make a measurement. The satellite will use the kickball to represent the light beam that is used in LIDAR to make this measurement by rolling it to the lunar surface point 1. The lunar surface will then return the ball by rolling it back to the satellite. The Timer will be responsible for identifying the amount of time it takes for the light beam (or the kickball) to leave the satellite, hit the lunar surface, and then return. The Recorder is then responsible for recording this information on the data chart. The remaining students, or scientists, in the classroom will be responsible for plotting this data on the graph worksheet based on the information collected and reported from the Recorder. This process will repeat until the satellite has collected data from each of the eight data collection points (1-8).

Once students have created their graphs, the host will instruct them to analyze what they see and then turn their graphs over (upside down). They should now see the opposite of what they originally analyzed. Where there were peaks on the graph, they should now see depressions. Where there were depressions on the graph, they should now see peaks. Students will be guided through a discussion to understand that when they turn their graphs over, they are seeing a representation of the topography of the mission assignment. They will learn about the time/distance relationship between the satellite and the lunar surface. The greater time value for a specific location signifies that it took the light beam longer to reach that point on the surface and return. This means that the light beam was reaching a lower point or a lower altitude on the surface. A lower amount of time recorded at a specific location signifies that it took the light beam a shorter amount of time to reach that point on the surface and return. Students will then understand that the light beam must be reaching a higher point or a peak on the measured surface.

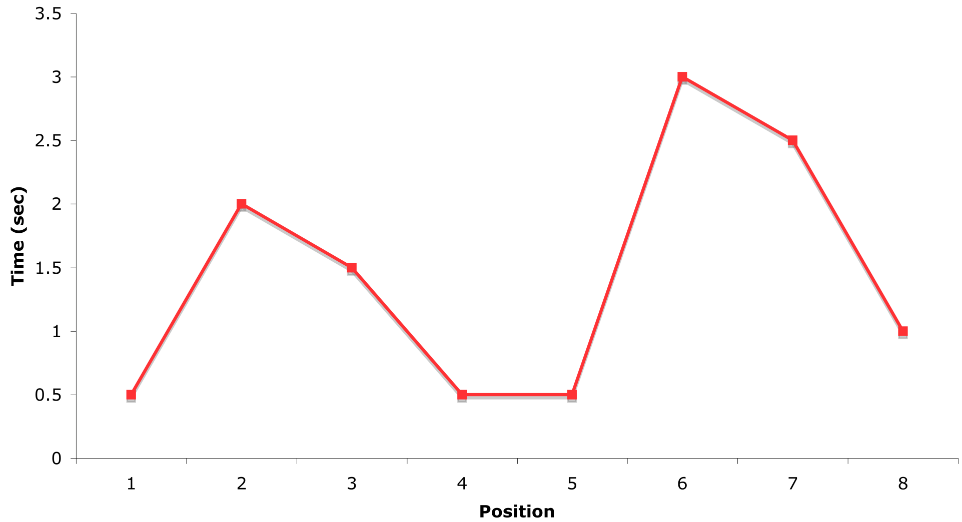

Figure 1. Sample line graph similar to what students will draft during LIDAR activity.

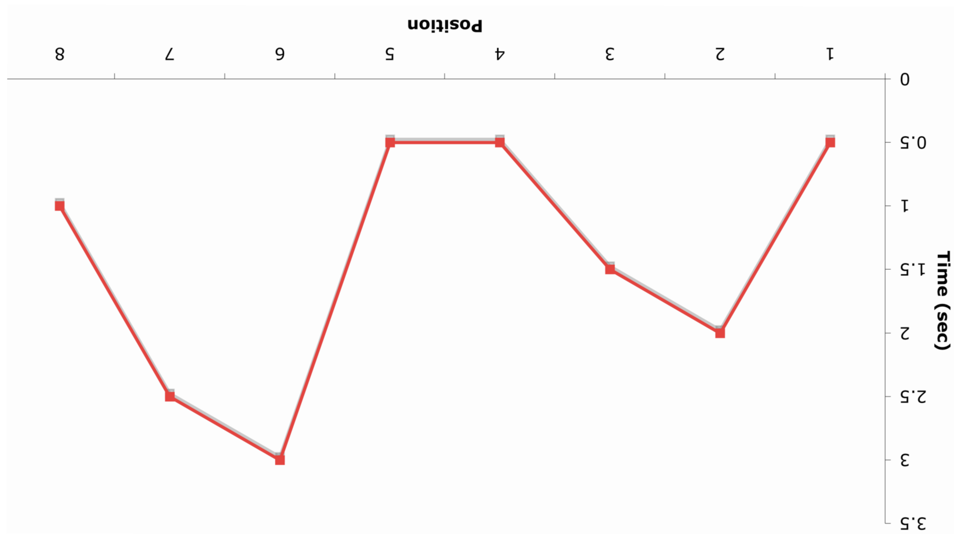

Figure 2. The students turn the graph upside down to represent the “topographic features” of the activity. For example, position 4 to 5 is a “mountain”, and position 6 to 7 is a “crater”.

LIDAR Mission Assignment Materials:

- LIDAR Activity Graph, p.16 (1 per student)
- Data table, p.17 (1 for data recorder)
- Pencils
- 1 Kickball (or ball of similar size)
- 1 Timer/Stopwatch
- 8 student volunteers to represent lunar surface
- 1 student volunteer to represent satellite
- 1 student volunteer to time the activity
- 1 student volunteer to record data
- (Optional) Chart Paper and Marker / Chalkboard / Whiteboard / Overhead

Post Videoconference Activity:

Measure the diameter of a lunar crater. Students will need a ruler, pencil, paper, calculator, and a Moon lithograph that can be found at:

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Earths_Moon_Lithograph.html

They will need pre-knowledge of how to apply a ratio. Students select one crater from the lithograph and measure its diameter in millimeters. Then, they will measure the diameter of the Moon in the picture (millimeters). Students can find the actual diameter of the Moon (kilometers) from information that is listed on the back of the lithograph. They will set up an equation and find the actual diameter of the selected crater.

$$\frac{\text{Measured crater diameter (picture, mm)}}{\text{Measured Moon diameter (picture, mm)}} = \frac{\text{Actual crater diameter (unknown km)}}{\text{Actual Moon diameter (3475 km)}}$$

Extension: How does the crater you just measured compare to the crater that LCROSS will create?

http://quest.nasa.gov/lunar/lcross/CraterSizes.htm

Videoconference Outline

I. Welcome
II. Introduction of Wall-E
III. NASA Science Missions
IV. LRO Mission
   a. Mission Objective 1, creating a topographic map of the lunar surface
      i. LIDAR Activity
      ii. How the satellite will orbit the Moon
V. LCROSS Mission
   a. Mission Objective 2, searching for the presence of frozen water
      i. Discussion on sites to locate ice on the Moon
VI. Conclusion
VII. Q & A
VIII. Good-Bye

Vocabulary

Altimetry: The measurement of different elevations of a land surface.

Data: Facts, statistics, or items of information.

Impactor: An object that collides with a land surface.

Instrument: A device for controlling, measuring, or recording data.

LIDAR: (Light Detection and Ranging) is a technique that uses pulses of light to find range and/or other information about a distant object.

Orbit: The path followed by a satellite.

RADAR: (Radio Detection and Ranging) is a system that uses radio waves to identify the speed or range of objects.

Range: The distance between a satellite and a target to be measured.

Relief: The terrain, or various elevations, of a land surface.

Remote Sensing: The technique or process of obtaining data or images from a distance, as from satellites or aircraft.

SONAR: (Sound Navigation and Ranging) is a technique that uses sound waves underwater to detect objects.

Satellite: In the context of this module, a device designed to be launched into orbit around the Earth, another planet, the sun, etc.

Sensor: A mechanical device sensitive to light, temperature, radiation level, or the like, that transmits a signal to a measuring or control instrument, such as a computer.

Surface: The outer face, outside, or exterior boundary of a thing; outermost or uppermost layer or area.

Swath: The area being imaged on a surface by a satellite during an orbit.

Topography: the study of surface features. A topographic map shows changes in the elevation of surface features, such as mountains, valleys, plains and craters.

Videoconference Guidelines

Teachers, please review the following points with your students prior to the event:

- Videoconference is a two-way event. Students and NASA presenters can see and hear one another.
- Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.
- Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
- Teacher(s) should moderate students' questions and answers.

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	1. Print a copy of the module for your reference.
	2. Have the students complete the pre-assessment.
	3. Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	4. Review the Audience Guidelines listed above with your students.

	Day of the Conference Requirements
	1. The students are encouraged to ask the NASA presenter relevant questions about the videoconference event.
	2. Follow up questions can be continued after the conference through e-mail.

	Post - Conference Requirements
	1. Have the students take the Post-Assessment to demonstrate their knowledge of the subject.
	2. Teacher(s) and students fill out the event feedback.

Pre and Post Assessment

1. True or False: Satellites are spacecraft that carry only one instrument at a time to complete a mission.
    a. True
    b. False

2. One of the missions of the Lunar Reconnaissance Orbiter is to:
    a. Orbit the moon, collect data, and aid scientists in creating a map of the moon.
    b. Replace solar panels on the International Space Station.
    c. Orbit the moon with a crew of astronauts.
    d. Begin construction on a future lunar base.

3. What does LIDAR technology use to make measurements and collect data?
    a. Microwaves
    b. Radio Waves
    c. Sound Waves
    d. Light Waves

4. What is a correct definition for *topography*?
    a. The depth of craters on the moon.
    b. The data collected by a satellite orbiting Earth.
    c. The relief features or features of a surface of different elevations.
    d. The road map of a specific location.

5. Briefly explain how LIDAR is used in remote detection missions in space and compare that to how RADAR or SONAR is used in remote detection missions here on Earth.

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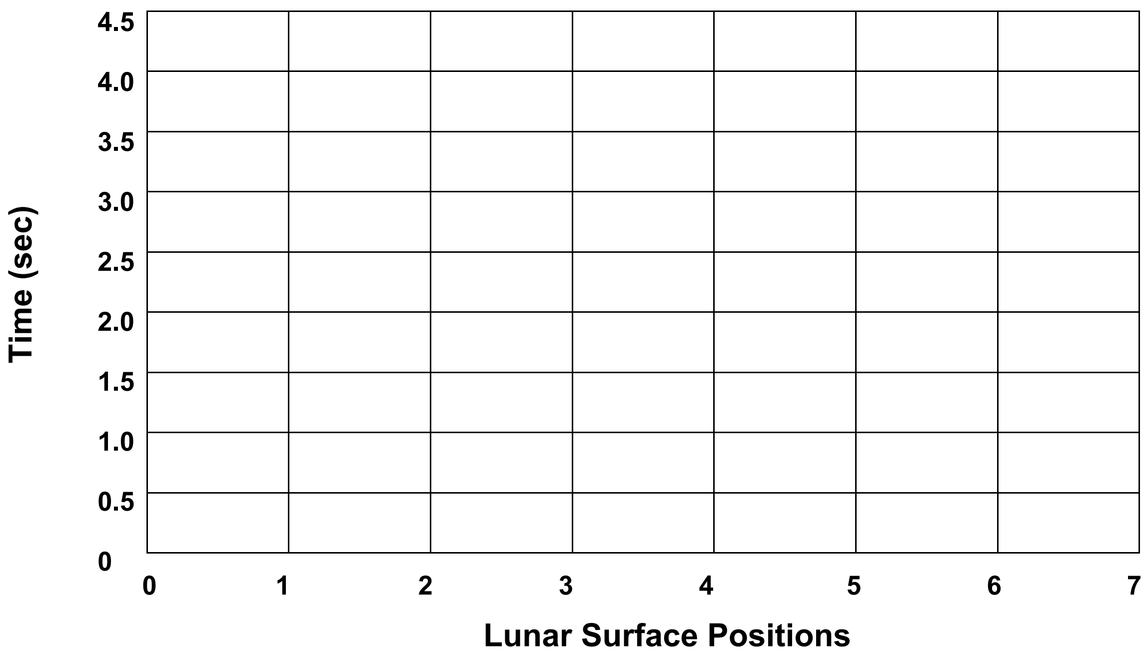
6. Using the following data, plot the data points on the graph below, then connect the dots to illustrate the topography section of the lunar surface being studied:



Lunar Surface Positions	**Signal time from satellite to surface and back**
Point 1	3.5 seconds
Point 2	3.0 seconds
Point 3	0.5 seconds
Point 4	1.0 seconds
Point 5	2.0 seconds
Point 6	2.5 seconds
Point 7	2.0 seconds

7. Turn your graph upside down. From what you see in your graph in this position, summarize the relationship between the time it takes for the light beam to return to the sensor and the height of the lunar surface.

Answer Key

1. B

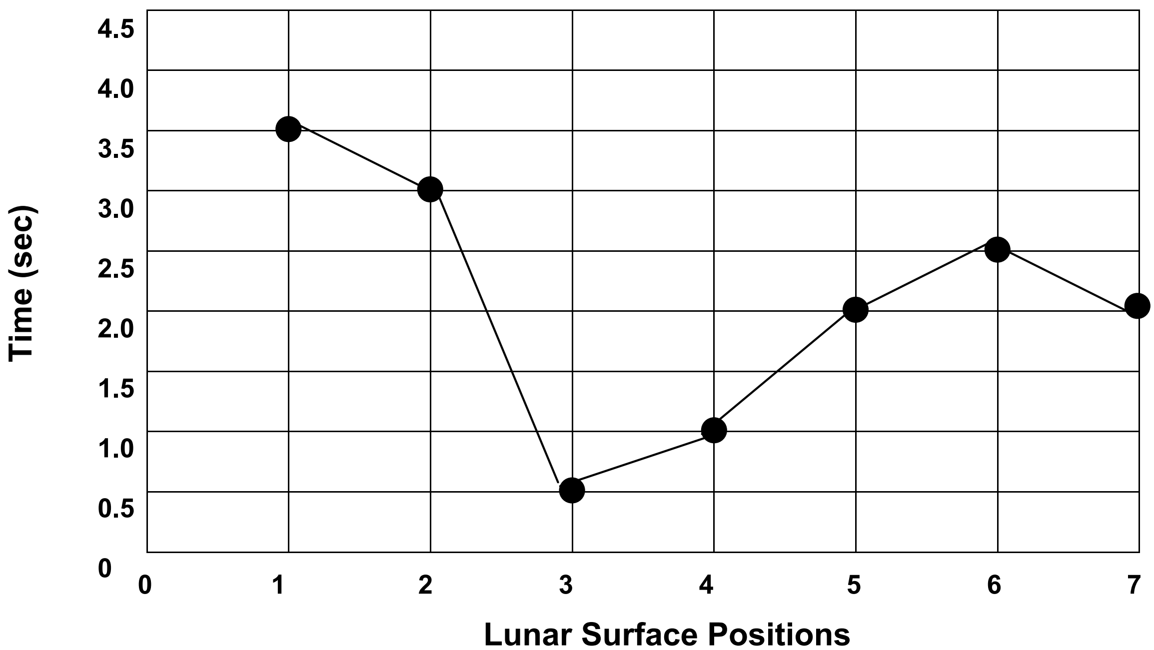
2. A

3. D

4. C

5. LIDAR uses light ways while RADAR uses radio waves and SONAR uses sound waves. The signal is sent from the satellite to a distant object, which is then bounced back to the satellite. Knowing the time it takes for the signal to travel from and to the satellite, and the speed of light/radio/sound waves, the distance from the object to the satellite can be calculated.

6.



7. The longer the time period for a signal to return to the satellite, the farther away the object is from the satellite. For example, it would take less time for a signal to return if hitting a mountain than it would take to bounce back from a crater in the surface.

NASA Education Evaluation

Currently the Office of Education is undergoing a major change for its on-line interface for education evaluation. We may need a few minutes of your time before or after a DLN event to answer questions that we will need to record until the new system is up and running. ***So please, remember, to keep these events free, we need your feedback!***

Additional Resources

Related LRO Activities:

http://lunar.gsfc.nasa.gov/forkids.html

The LOLA Instrument

http://lunar.gsfc.nasa.gov/lola/

Educator's Guide: Exploring the Moon

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Exploring.the.Moon.html

Moon Lithograph:

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Earths_Moon_Lithograph.html

Lunar Photo of the Day:

http://lpod.wikispaces.com

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Special thanks to the people at:

LIDAR Activity – Build Your Own Topographic Map

LIDAR Activity – Build Your Own Topographic Map

DATA TABLE

Lunar Surface Positions	Signal time from satellite to surface and back (seconds)
Point 1	
Point 2	
Point 3	
Point 4	
Point 5	
Point 6	
Point 7	
Point 8	